A GUIDE FOR PREPARATION
OF TACTICAL DATA SYSTEM
OPERATIONAL SPECIFICATIONS

November 1966

Prepared for

FLEET COMPUTER PROGRAMMING CENTER, PACIFIC
San Diego, California

Under Contract N123(61756)56869A

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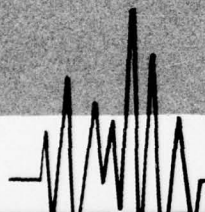FLEET COMPUTER PROGRAMMING CENTER, PACIFIC
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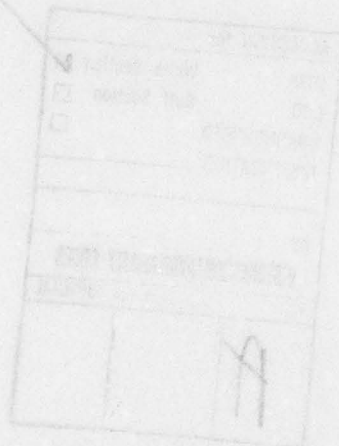Notes: 1. The portion of the text affected by the current change is indicated by a vertical line in the outer margins of the page.

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FOREWORD

     This document was prepared in close coordination with the Fleet Computer Programming Center, Pacific, as part of a complete set of documentation for the procurement and management of computer programs. As such it can be considered an integrated part of a total system approach to computer program development and procurement. In the development of this approach, it was necessary to prepare each package incrementally. Then the increments were integrated into the whole through an iterative process.

     At the time of publication, several iterations have been completed, with coordinated inputs from all known sources. However, the process of updating and refining this document should be a continuous one so that it will be a viable document incorporating all advances and evolutionary changes in computer programming.

     The following documents, of which this is one, comprise the system documentation package:

| Title	Publication No.
A Preparation Guide for Requests for Quotation for Tactical Data System Computer Programs	414-04-1-689
A Procurement Specification for Tactical Data System Computer Programs	414-04-2-690
A Guide for Preparation of Tactical Data System Operational Specifications	414-04-3-691
Tactical Data System Computer Programming Specification	414-04-4-692
A Specification for Tactical Data System Computer Program Documentation	414-04-5-693
A Management Manual for Tactical Data System Computer Programs	414-04-6-694

1. GENERAL

Tactical Data Systems Operational Specifications will be
prepared in accordance with this preparation guide and in response
to the applicable Technical Development Plan (TDP) and its enclosed
Specific Operational Requirement (SOR). The Operational Specifica-
tion and the applicable equipment description are the two basic
guidance documents which are prepared within the framework of
responsibility of the TDS Computer Program Manager. These docu-
ments, including their appendices, provide the information required
(to the lowest available level of detail that is meaningful) for
the development of each computer program.

Operational Specifications are prepared at the following two
levels of computer programming (see Figure 1):

(1) Program Level. Defines the objectives and goals of the
program, establishes the overall design envelope, inte-
grates the program specification with other TDS's; and,
above all, ensures that the most recent inputs from the
Fleet are considered.

(2) Module Level. Individual program modules (including
one or more functions) required to provide an overall TDS
program, including support functions (e.g., tracking,
display, executive, etc.).

At the program level, the functional interaction with the user
(Fleet) and other tactical data systems is specified. At the
module level the interaction between the program level and the
equipment is specified. Although the two levels need not be
prepared by the same activity, close coordination is important.

Both levels should be prepared concurrently to ensure that
achievable performance is consistent with user requirements. During
the early stages of specification preparation, assumptions concern-
ing the Fleet requirements and the equipment capability must be
clearly stated. In making assumptions, uncertainties should be
identified and classified according to their criticality,
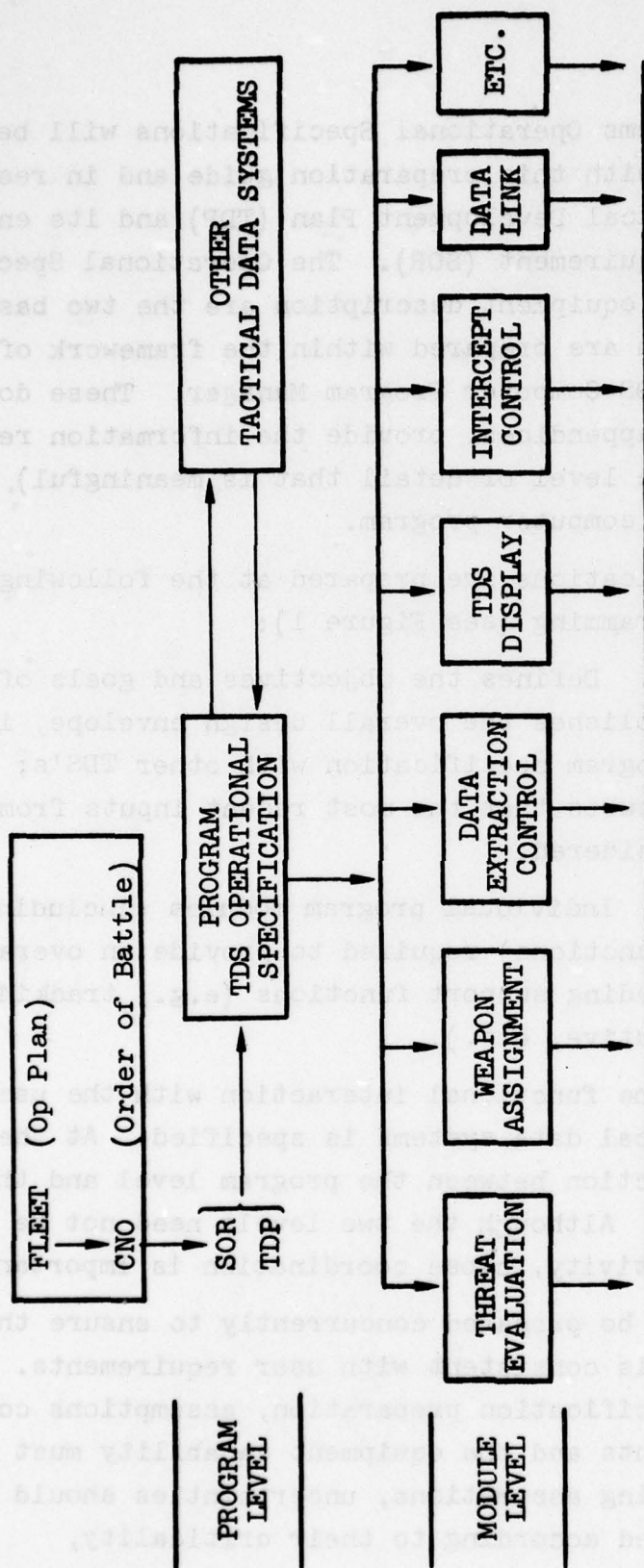
Detailed Operational Characteristics
Including:
-- Internal inputs and outputs
-- External inputs and outputs
-- Basic operational constraints
-- Assumptions

FLEET (Op Plan)
CNO (Order of Battle)
SOR
TDP

PROGRAM TDS OPERATIONAL SPECIFICATION

OTHER TACTICAL DATA SYSTEMS

THREAT EVALUATION
WEAPON ASSIGNMENT
DATA EXTRACTION CONTROL
TDS DISPLAY
INTERCEPT CONTROL
DATA LINK
ETC.

PROGRAM LEVEL

MODULE LEVEL

FIGURE 1

OPERATIONAL SPECIFICATION STRUCTURE

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development trends, and the possibility of resolution into a certainty. Tables 1 and 2 are included as examples of a means for readily cataloging assumptions and uncertainties in the specification.

TABLE 1 OPERATIONAL SPECIFICATION ASSUMPTIONS (EXAMPLE)		
Activity	Program Level	Module Level
User (Fleet) 1. Airborne 2. Surface 3. Ashore	(List all assumptions)	(List assumptions)
Equipment 1. Radar 2. Computer 3. Etc.	(List all assumptions)	(List assumptions)

TABLE 2

OPERATIONAL SPECIFICATION UNCERTAINTIES (EXAMPLE)

Name	Criticality	Present Capability/ Requirement	Development Trend	Specification Requirement
Identify uncertainty by a short title.	Determine criticality to program development. Indicate assumption affiliation.	State present capability or requirement	Indicate present and forecast development trends	Specify requirement for breakthrough or acceptability of degraded performance/capability

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2. PURPOSE

The purpose of the Operational Specification is to define precisely the operational characteristics of a program or a module such that:

(1) The fleet user understands precisely the capabilities provided by the computer program (acceptability to the user), and

(2) Computer programs developed from the specification by different contractors result in identical input and output interfaces while operating under the same criteria and constraints. (Compatibility in system operation and equality in contractor bidding.)

(3) All information (in addition to the Equipment Description) which is required for completion of the computer program is provided in the basic document or in its appendices. (Efficiency in program development.)

3.   BACKGROUND

The purpose of the Operational Specification has rarely been achieved to the extent desired during the early stages of acquisition of TDS computer programs. As a result of this lack of definition, the following has occurred:

(1) The Fleet user has not become aware of all the capabilities of the computer program until a certain amount of operational experience has been accrued.

(2) Computer programming contractors have had incomplete or erroneous understanding of capabilities required of the program.

(3) Lack of efficiency has occurred in the development of computer programs because of the necessity for search and study of many documents to determine the required functions, criteria, and constraints.

4. DISCUSSION

The development of sufficiently definitive Operational Specifications is necessarily an iterative process. Functional descriptions of the computer program produced as part of the development of each program provide a useful means of augmenting the original Operational Specification. Information from these functional descriptions may be extracted and modified, if appropriate, and used to modify and augment the basic specification.

The process of successive revision of the Operational Specification by use of functional descriptions provides progressively more definitive operational specifications. In this manner, both government and contractor personnel achieve an increasingly clearer understanding of the program. This fact is of great importance in computer program development, particularly when personnel changes occur.

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5. CONTENT OF THE OPERATIONAL SPECIFICATION

5.1 General

The specification should contain all the information required to prepare a good computer program logic design. The Operational Specification and the Equipment Specifications are the two prime sources of characteristics and limitations surrounding the program to be developed.

Avoid weak Operational Specifications that do not adequately define the complete requirements for the program. If the Operational Specifications are weak, the programmers preparing the program may constantly question the requirements desired but not provided, or they may make unwarranted assumptions rather than call the programming center to determine limitations and specifications of the program.

The content of all Operational Specifications should be the same, but the level of detail is a function of the type contract to be let. For example, if the program desired is a revision of the tracking routine, the fixed input and output from the computer detector and interceptor programs would constrain the new tracking program to enable them to be compatible. Additionally, the revised tracking programs must operate within the time constraints allowed for that portion of the program associated with the tracking routine and must use the existing memory allocations.

In contrast, for the procurement of a new program, the constraints are limited to compatibility between input words from other routines and the output words to other routines which are also subject to procurement. When a complete procurement is anticipated, it is not very important whether new or old routines are modified, so long as the words are compatible. During an initial program procurement this freedom exists, but it does not permit the originator of an Operational Specification to ignore the requirement. The requirements for word compatibility, memory allocation, and run time must be provided in the Operational Specification.

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After the initial procurement is completed, the word defintions that have been devised by the programmers, the run times experienced during the program, and the memory allocations required by the program must be entered in the Operational Specification to provide a permanent record of the initial program. These data may be used as a base when modifications or revisions to the routines are being made.

5.2 Operational Specification

A sample table of contents and descriptions of the requirements for each of the sections of the Operational Specification follow.

SAMPLE
TABLE OF CONTENTS
FOR
(NAME OF SYSTEM)
OPERATIONAL SPECIFICATION

1. PROGRAM LEVEL OPERATIONAL SPECIFICATION

Include a statement that this specification level is intended to clarify the interfaces between the user (Fleet) and the equipment in terms of computer program routines.

1.1 User Requirements

Specify the user requirements as they will influence the computer program. Use the TDP, SOR, and recent inputs from the Fleet as a reference.

1.2 Intersystem Input and Output

Specify the input and output from and to other systems. Indicate any voids and uncertainties that must be clarified.

1.3 System Operational Constraints

Specify any system-level operational constraints and indicate the type encounter, threat size, and general environment. List the constraints by priorities desired.

1.4 Assumptions

List all the assumptions that have been made at this level and indicate when, how, and by whom they will be validated.

1.5 Uncertainties

Specify all uncertainties that will influence the program. Indicate (preferably in chart form) when, how, and by whom they will be resolved. In addition, classify the uncertainties in accordance with "importance of resolution" to the successful completion of the program, and potential risk to the overall system performance if not resolved.

NOTE

The importance of 1.4 and 1.5 cannot be overstressed. All parameters that cannot be clearly defined with certainty must be identified as assumptions or uncertainties.

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2. MODULE OPERATIONAL SPECIFICATION

2.1 Problem Statement

The problem statement is a nondetailed explanation of the module operational function or requirement that will be satisfied by the computer program developed from this operational specification. It also provides program design personnel with a general insight into the problem. When such information is available, it also provides attitudes and opinions of the fleet personnel in the operating squadrons who have contributed input to be used in the operational specification.

2.2 Computer and Peripheral Equipment Considerations

The computer program for a routine will be written in the language of a particular computer operating under a particular executive system. The peripheral equipment attached or available to the computer must be uniquely defined so that manuals and specifications associated with the equipment and software can be uniquely referenced. This section lists these reference requirements.

2.2.1 Equipment Description

Within this section, the equipment for which the program is being prepared is identified using exact nomenclature. The configuration of the equipment is identified by providing the modification and model numbers where applicable. The modification and model numbers are important, since the programmer may refer to equipment manuals or other documentation as sources of input for the preparation of the computer program. Needless to say, chaos would exist if the person used a Model 0 handbook for his source of capabilities, limitations, etc., when preparing a program for the Model 1 or 2 configuration of the same equipment.

2.2.2 Executive System

The computer manufacturer usually supplies an executive system with his computer hardware. This is a computer program which

monitors the interfaces between different parts of the computer. Several versions of an executive system may be available from a computer manufacturer. Also, revisions of the various versions will probably be made. It is very important for the programmer to know the correct name, version, and revision of the executive routine for which he will be programming. Specify any changes to the executive program necessary to implement specific functional requirements such as self-test, reliability, fault isolation, and degradation control demanded by operational requirements.

2.2.3 Compiler and Language

This section defines the compiler and language to be used, and explains the features of the compiler that will be used for the compilation. Generally speaking, the compiler will be completely documented by a separate manual designed for this purpose. When this is the case, the manual must be referenced by name, identifying number, and date of issue in effect for the procurement.

2.2.4 Summary

In summary, the most important consideration of Section 3 is configuration identification such that the task can be performed. There are two problems associated with configuration; producing information from data that is too far behind or ahead of the system configuration. This would be especially true in the operational specifications associated with early configurations of the program. Since the early configurations of a program must work on the early configurations of equipment, the most current form of any document is not likely to be compatible with an early configuration of the system. Therefore, it is imperative that careful consideration be given in Section 3 to the exact configuration of the equipment for which the program is being prepared. Also, it is important that all configurations of the required data listed in this section match the configurations under consideration, and that listed configurations neither lag nor precede the actual system configuration.

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2.3 Referenced Documents

This section consists of a listing of the names and numbers of the referenced documents. It is prepared by compiling a list of references made in other sections of the operational specification and including them in this section. As such, it includes all of the documents required in addition to the Operational Specification to prepare a computer program related to the routine thereby simplifying the gathering of the data required for a procurement package. For each document listed, specify the date, revision number and originating agency in addition to normal identifications.

Many of the parameters surrounding the equipment and functions that provide input to various routines are under control of personnel different from those developing the particular routine for which the Operational Specification is being developed. In this case, any documents providing constraints should be referenced rather than repeating the constraints within the operational specification. An example would be the data rate of the computer detector or the word format of a link data message. These types of information are controlled by other documents and could cause confusion and repetition if listed. When the data link message is changed, the documentation for the configuration of the data link message will be revised accordingly. There is, however, no way to know that the configuration of this data link message is provided within one of the operational specifications. Thus, there would be no way for a person to ensure that all possible listings of the data link message format were updated. The general ground rule for referencing or incorporating these configurations is the source of control.

2.4 Accuracies

The accuracy required by a computer program should be part of the information supplied to a programmer, since additional programming effort may be required to increase the accuracy of a fixed-word computer, and additional storage is needed to extend the accuracy of a character computer.

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2.4.1 Input Accuracy Constraints

In this paragraph, the input accuracy limitations are either specified or discussed in Section 4. This portion of the Operational Specification should be a listing of the accuracies of all input data or commands incident on or available to the system.

2.4.2 Output Accuracy Constraints

Because the input equipment is capable of providing only a specific accuracy, the output equipment is limited to functioning within a certain level of accuracy. A parallel constraint exists because it would not be logical to produce any more accuracy than the output device is capable of using. The reduced requirement resulting from the limited capability of the output device may provide a memory saving which can be used to increase the number of tracks handled, or it might improve some other feature. Further, algorithms used by the programmer will be very dependent on the accuracy necessary.

2.4.3 Required Accuracies of the Computer Program

To prevent injection of error as a result of the reduced computer accuracy, some computer accuracy parameters must be defined. They must provide for more accuracy than the data provided by the input device or the data required by the output device. The degree of accuracy overlap is subject to negotiation if it has not been defined in this section. In that case, the programming accuracies that were actually determined and used after the completion of initial programming should be extracted and located in this portion of the operational specification. They can then be used as an input for future procurements of modifications to this particular routine.

2.5 External Error

This section is concerned primarily with input data from operator consoles; however, it does have other applications to computer programming. When it is possible for the input data to be applied in error, there must be some provision for alerting the operator that erroneous data is being provided after a specific number of attempts have been made by the computer to operate on the

erroneous data. When these error limits are applicable, they should be provided in Section 5 of the Operational Specification. If no error limits are applicable to the portion of the computer program associated with this operational specification, this section will be marked "Not Applicable."

2.6 Word Characteristics

Word characteristics of the input from or output to other routines must be defined even when the program is an initial procurement. In this case, a requirement is made that input and output words be compatible with the other operational specifications with which they must interface. Any reference to other operational specifications should be specific rather than general. After the completion of the initial procurement, the word configuration that was used should be obtained from the computer program documentation and inserted in the operational specification to serve as a base for subsequent procurement of revisions to the program.

2.6.1 Input Word or Switch Characteristics

The characteristics of the input word from another routine in the program or the signal characteristic of an output of a switch at the console are described in this paragraph. For switch input, the point of computer access by the program, the voltage level or the bit representation of the ON or OFF position, or the setting of the switch must be provided. The input word must be defined by name and the work configuration must be provided.

When the procurement is for a revision, and if the computer for which the operational specification is being prepared is a special-purpose computer that uses a drum memory, the drum location and word configuration must be provided. If the computer for which the operational specification is being prepared is a general-purpose machine, the identifying name by which the word can be called from memory, and the word configuration, must be provided, so that masking and shifting can be accomplished, when necessary.

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2.6.2 Output Word or Display Characteristics

The same requirements surround the output word resulting from the routine. If the output is a display symbol or light, the characteristic of the symbol or proper nomenclature of the light should be provided at this point.

If the procurement is for a program revision and if the word is to be stored on a special-purpose computer with a drum memory, the drum location and word bit configuration must be provided. If the output word is being developed for a general-purpose computer, the calling name and the bit configuration of the word must be provided.

2.7 Memory Requirements

Since the core memory must be allocated among the various routines to be operating within the framework of the whole program, specific memory allocations must be provided. Here again, the initial and subsequent procurements must be analyzed. In the initial procurement, the requirement for memory may only be the constraint that the total memory allocation of the program does not exceed the total memory capability of the machine. After the completion of the memory allocations on the initial procurement, the memory allotted plus a proportionate division of the remaining memory must be allocated to the routine and specified in the operational specification. Subsequent procurements can then be initiated within the framework of the memory capability of the computer program.

2.8 Program Time Allocations

In this section, the time required to run the routine covered by the operational specifications must be provided. All of the considerations of the initial and subsequent procurement discussed under Memory Requirements apply equally to the definition of program run time allocations.

Timing constraints imposed by real time operation of other portions of the program or equipments associated with the program must also be provided.

2.9 Specific Requirements

The specific requirements of each particular routine are provided in this section. These are the requirements that the routine should meet to accomplish the initial objective. An example of these types of requirements for tracking would be the establishment of, and the ground rules surrounding, the determination that a target is an air target rather than a surface target, etc.

2.10 Testing Requirements

As established in the specification for computer programming, logic, simulation, and operational testing are available for each of the routines developed in a procurement. Logic testing literally tests that the program will run as designed. Simulation testing establishes that the program will meet the operational requirements in a simulated environment, and operational testing is conducted to evaluate the program under actual operational conditions and situations.

Surrounding such tests are the parameter of the initial and subsequent procurements. During an initial procurement, the various testing routines probably will have to be developed for each of the phases of the testing. In subsequent procurements, however, the initial logic and simulation testing routines developed for the initial procurement may be adequate to verify the performance of the routine during the subsequent revision procurement. When this is so, the routines to be used to verify the program as designed should be referenced by name and configuration number. For such cases, the configuration constraints discussed in Section 3 would apply.

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